INVESTIGATION OF RARE EARTH ELEMENT OCCURRENCES NEAR KOOK LAKE

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** Field Report

UNITED STATES DEPARTMENT OF THE INTERIOR

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INTRODUCTION

Kook Lake is located 28 km southwest of Juneau on the east coast of Chichagof Island, in the Sitka C-3 and C-4 quadrangles (fig. 1). Kook Lake drains eastward into Basket Bay via a 1.6 km long creek which intermittently flows underground through limestone caves. Float planes, which can easily land on Kook Lake, are the most practical means of reaching the area. At Kook Lake there is a Forest Service cabin which is available for rental through the Chichagof National Forest, Sitka Ranger District. The village of Tenakee is located approximately 7 km to the north on Tenakee Inlet and A system of logging roads connects the Kook Lake area with Tenakee Inlet. Access from this direction is possible, and lodging is available with permission at the Forest Service staff facility at Corner Bay. A boat could be used to haul ~~the camp~~ heavy ~~and~~ gear from Juneau to the dock at Corner Bay. Overland transport would be needed from there and motor bikes or four wheel ATV's would be ideal. The Kook Lake cabin is not on the road system but is connected by an unmarked trail. Terrain is steep, with relief of up to 770 m within 1 km of Kook Lake, and vegetation is generally dense. Many of the lower slopes have been logged and are now heavily tangled with slash.

Chichagof Island was mapped in 1963 by Loney, Berg, Pomeroy, and Brew (1), followed by a report on the age of plutonic rocks in the area in 1965 by Lanphere, Loney and Brew (2). Eakin (3) explored the area in 1975 as part of a uranium investigation of southeast Alaska and found area ~~with~~ exhibited up to 6times the regional radiometric background. Subsequently Mapco and RAA staked several hundred mining claims (fig. 1). There are verbal reports of anomalous metal and fluorine concentrations in stream waters and discovery of mineralized creek float at one location. In 1988, the AFOC conducted a 9 man-day reconnaissance of the

Kook Lake intrusive complex to evaluate potential for REE occurrences in the area.

SAMPLING

A total of 37 representative grab and continuous chip samples were collected. The samples were crushed pulverized and tested by Nuclear Activation Services of Ann Arbor, Michigan, for major oxides and selected elements (see appendix 1). In addition, 12 pan concentrates, and 14 stream sediment and soil samples were collected and analyzed for Nb, Sn, Ta, Th, Ti, U, W, Y, Zr, La, and Ce and the results are presented in Tables 1 through 4, arranged according to location (see appendix 2 for analytical methods and detection limits). Sample locations are plotted on fig. 2.

Scintillometers were carried in the field and the readings obtained from outcrops where rock samples were collected ~~are~~ and subsequently included with sample descriptions. Average background in the Kook Lake area was between 100 and 300 cps. For future reference, all readings reported herein were standardized to the Bureau's Scintrex GIS-5 gamma-ray spectrometer.

GEOLOGY

The oldest rocks in the study area are hornfels, schist, and marble (fig. 1). Hornfels is the most common rock type near the Kook Lake igneous complex. It is generally f grained, black to green in color, with poorly developed or absent schistocity. Hornfels may contain up to 20% sulfides, mostly as pyrite. There are also pods or lenses of marble within the hornsfels unit. Sample descriptions and elemental analyses for samples of this unit are listed in Table 5. The areal distribution of the metasedimentary rocks suggests it was intruded and probably metamorphosed by

Paleozoic (2) plutonism. The field relationship with plutonic rocks is for the most part obscured by dense vegetation and steep terrain but where the contact is exposed, the Paleozoic pluton and the metamorphic unit are juxtaposed by faulting. No fossils have been found in the metamorphic rocks so the assigned Paleozoic age is speculative (2).

Plutonic rocks in the Kook Lake area are part of a Paleozoic intrusive complex which extends for 35 km along a NW-SE trending belt from Tenakee Inlet southward to Point Hayes. The complex apparently extends further to the NW to include approximately 10 square km of Paleozoic intrusive bedrock mapped to the north of Tenakee Inlet (fig. 2). Altogether these plutonic rocks range in composition from granite to hornblende diorite, and include several phases of syenite and nepheline syenite. In general, the compositions are fine-to medium-grained, and only one piece of pegmatite was found in float. Various phases of the intrusive complex were collected and analyzed in the course of this study and the results are presented in Table 6.

The eastern end of Kook Lake lies in a northwest trending belt of Devonian limestone and locally boulder conglomerate. The limestone is buff-to gray-colored and caps ridges east of Kook Lake. The boulder conglomerate contains well-rounded clasts up to 0.3 m in diameter consisting of siliceous and calcareous metasedimentary rock, metaconglomerate, syenite, and coarse-grained felsic rock in a siliceous matrix. This unit post-dates the intrusive complex as evidenced by the inclusion of granitic and syenitic casts. Locally, however, the conglomerate is cut by carbonate lenses and intruded by syenitic and felsic dikes. THe contact between the limestone and the Paleozonic intrusive is suggested to be an east-dipping trust fault based on the abrupt linear contact that correlates with steep vertical cliffs.

Listed in Table 7 are sample descriptions and analytical results from examination of the conglomerate.

At least two dike systems have been recognized in the study area. One episode ~~is~~ has intruded the metasedimentary unit. It was sampled in four locations (NS 25693, 26231, 26928, and 25691) and ranged in composition from rhyolite to syenite to syenodiorite. The descriptions and analyses of these samples are presented in Table 8.

A second and potentially younger episode of dike intrusions cut the Devonian metaconglomerate and are locally mineralized. Where sampled, the composition was consistently syenitic and generally enriched in U, Th, and REE. Table 9 presents data from these samples.

A large Mesozoic (2) granitic pluton is mapped as a NW-trending belt to the southwest of the study area and in several smaller areas to the northeast (fig. 3). Although these rocks have not been found in the study area, they may have some relationship to the alteration and mineralization as discussed later in this report.

MINERALIZATION

For comparison, the average abundance of total plus yttrium granitic rocks is 334 ppm, the average crustal abundance in carbonate-bearing sedimentary rocks is 16-159 ppm, and in shale is 235 ppm. In general shale and granite are the rock types which statistically have the highest REE content (as compared to sandstone, basalt etc.) The average content of U in felsic igneous rocks is 3.5 ppm; in limestone, 2.5 ppm; and in shale, 4.1 ppm (4,5).

SAMPLE 26228: 1200 cps; elevated Th, U, and REE= 1077 ppm.

This sample was collected from a 0.1 m syenite dike intruding the boulder conglomerate. Up stream and to the west, the conglomerate grades into a pebble conglomerate where it grades to a finer grained metasedimentary unit to the east. The leucocratic syenite dike, which trends N60W dipping 40N along the 3 m exposure, is coarse-grained, has up to 10% pyrite, molybdenite, and chalcopyrite, plus other fine-grained sulfides. The contact of the syenite dike and the conglomerate is sharp, well defined. There are no contact slickensides or fault gouge observed.

SAMPLE 26231: 480 cps; slightly elevated U, Th; REE=229

This sample was collected approximately 300 m to the east and downstream of sample 26228. It is a sulfide bearing syenodiorite dike which interfingers with or intrudes the Paleozoic metasedimentary unit. Disseminated sulfides, identified as chalcopyrite, sphalerite, and bornite appear to be evenly distributed through the sample. Epidote and carbonate from narrow veinlets.

SAMPLE 26943; 2400 cps; U, Th

SAMPLE 26941; 1300 cps; U, Th

Southeast of Kook Lake a carbonate-bearing boulder conglomerate and graywacke strata is cut by dikes, faults and shears. Elevated U and Th values were found in a hematitic, magnetite bearing, coarsely crystalline syenite. In sample 26940, collected near these two samples, the "clots" of magnetite registered over 750 cps. Samples 26943 and 26941 both exhibit visible carbonate alteration, which in hand specimen appears to be concentrated in microfractures.

SAMPLE 26923; 2700 cps; Th

Hematitic and manganese stained aegirine(?) syenite was found as float along a N70E trend of radiometric highs within the Paleozoic syenite. Soil samples collected approximately 300 m from the chip sample had elevated Nb, Th, Zr, La, and Ce (samples 26309, 26925).

SAMPLE 25682; slightly elevated U, V

This sample was collected in a quarry along the road leading to Tenakee Inlet (fig. 1). There is a small gossan on the south end of the pit that is localized along the hornfels, intrusive contact. The pit is oriented along the intrusive granite metasediment fault contact. This is the only location of granite that was located in the study area.

SAMPLE 25691; 360 cps; REE=275

Bedrock in the Kook Creek drainage , where exposed is the hornfels, schist, and marble unit described by Loney et Al (1). At an elevation of approximately 550 ft. a sodalite(?) syenite dike was found intruding or interfingered with the metasediment unit. With a sharp contact and no slickensides nor contact aureole.

SAMPLE 26307; no cps; REE=273

Sample is chips of slightly radioactive syenite bedrock.

SAMPLE 26310; 650 cps; REE=251

Chip sample of a light-colored silicic metasedimentary rock which exhibits residual strata, and is exposed in a small gouge zone. Microfractures through the rock are filled with silicic material and there appears to be a later episode of carbonate alteration, localized along these fractures. There is disseminated pyrite through the sample in addition to a localization of sulfides (pyrite) along the silica/carbonate filled fractures. Float rock with slickensides found in the area suggests this unit is in possible fault contact with the syenite, which outcrops 17 m to the north.

EXPLORATION RECOMMENDATIONS

Sampling Techniques

Soil samples, collected at a radioactive anomaly of up to 1200 cps, have elevated values of various elements. Niobium values from soil analyses are over four times greater than the measured Nb values in stream sediments from the area, and the statistical average Nb content of soils (5). Stream sediment and pan concentrates in the Kook Lake area do not contain anomalous values of La, however, soils are enriched up to three times the average soil abundance of La (5). U and Th are enriched in soils sampled in this study up to 50 times the average crustal abundance. Stream sediments and pan concentrates show no selective enrichment of U or Th. Note that soil samples were collected in areas with high scintillometer readings. The conclusion is that soils do reflect the elevated values expected from an area with high cps, however, carrying a scintillometer in the field is a lot cheaper than running a soil grid.

Potential Mineralized Sites

A zone of anomalously high REE values is located in the SE quarter of section 28, southcentral section 27, and SW quarter of section 26, T49S, R65E. The break in slope in this area and the abnormal right angle bend in the unnamed creek is probably lithologically controlled and is the contact between the metasedimentary unit and the Paleozoic intrusive complex. Also in this area are unmapped lenses of the Devonian conglomeritic unit intruded by syenitic dikes with elevated REE values. Mapping in this area should be concentrated on locating the metasedimentary-conglomerate-syenite contact and looking for additional mineralized syenite dikes intruding the conglomerate. These dikes can be located using a scintillometer.

It appears that the U-Th mineralization is localized in syenite dikes and also within the syenite complex. The concentration appears to be related to the Fe oxidation state (associated hematitic alteration) and to carbonate alteration.

REE mineralization with associated U-Th, is at least post-Devonian, as the highest values are found in veins or dikes crosscutting the Devonian conglomerate. In addition, it appears as though the carbonate may have something to do with the chemical controls of ore deposition.

Geologic Controls of Mineralization

Two hypothesis as to the source of mineralization in the Kook Lake area should be employed for implementing additional exploration programs in the area. One idea is that the U, Th, and REE were concentrated in late stage emanations from the Paleozoic syenitic complex. Fluids were "stored" throughout the period of time in which limestone and c were accumulating, fracturing took place and the enriched fluids were injected into the fractures. The problem with this idea is why were the the dikes silica-poor?

Mineralization may be related to the granitic complex located to the southwest and northeast in three possible ways: a) mineralizing fluids may have been mobilized from the Devonian syenitic complex because of heating during Mesozoic granitic emplacement; b) mineralizing fluids may have collected during generation of the Mesozoic magma, and injected along fractures formed during emplacement of the pluton; c) mineralizing fluids may be late- stage residual fluids of the Mesozoic granitic complex are made. Dating of the mineralized dikes would be beneficial for the comparison also.

The contact between the hornfels unit and the Mesozoic intrusives should be examined, especially near the contacts of the limestone/hornfels and intrusive, as this seems to be where the mineralization is localized in and around the Paleozoic intrusive.

Lastly, reexamine sample 26310 to determine if it is a dike or a sedimentary layer?

Table 1.- PAN CONCENTRATE, STREAM SEDIMENT AND SOIL SAMPLE ANALYSES, NORTHWEST SECTION OF STUDY AREA, analyses reported in ppm

Sample Number	Sample type	Total sample size	Concentrate, in g	Nb	Sn	Ta	Th	Ti	U	W	Y	Zr	La	Ce
25678	Pan con	9 kg	126.34	63	2	2	2	7400	2	5	37	770	92	170
25687	Pan con	18 kg	161.80	26	2	2	2	6400	2	8	24	170	52	100
26226	Pan con	9 kg	52.00	27	2	4	2	5600	2	3	26	150	40	73
26227	Stream sed	NA	NA	31	8	2	2	5700	2	3	26	150	43	78
26232	Pan con	9 kg	141.75	26	2	2	2	6200	2	3	23	170	48	93
26233	Stream sed	NA	NA	21	3	2	2	6000	2	3	20	110	43	77
26235	Soil	NA	NA	27	2	4	2	3100	2	25	18	190	40	67

Sample Number	Description
25678	syenite float from drainage north of Kook Lake
25687	sample from bedrock riffles, small heavy fraction, float predominantly conglomerate, meta-sedimentary rock,minor syenite
26226	eastern drainage below upper lake, gravel predominantly metasediment, some syenite
26227	stream sediment,see pan con 26226
26232	small fine fraction and minor black sand
26233	stream sediment, see pan con 26232
26235	limonitic soil sample to .3m depth

Table 2.- PAN CONCENTRATE, STREAM SEDIMENT AND SOIL SAMPLE ANALYSES, NORTH OF KOOK LAKE, analyses reported in ppm

Sample Number	Sample type	Total sample size	Concentrate, in g	Nb	Sn	Ta	Th	Ti	U	W	Y	Zr	La	Ce
26930	Stream sed	NA	NA	36	2	6	2	3900	2	4	34	280	54	92
26931	Pan con	9 kg	27.20	61	2	2	2	14000	2	3	32	750	71	130
26932	Pan con	NA	54.82	36	8	2	2	10000	2	2	24	350	68	125
26933	Stream sed	NA	NA	19	2	2	2	5400	2	3	22	140	34	61

Sample Number	Description
26930	stream sediment
26931	aggregate of graywacke, shale, limestone and syenodiorite
26932	gravel consists of graywacke, limestone, and syenite
26933	stream sediment, see pan con 26932

Table 3.- PAN CONCENTRATE, STREAM SEDIMENT AND SOIL SAMPLE ANALYSES, SOUTH OF KOOK LAKE, analyses reported in ppm

Sample Number	Sample type	Total sample size	Concentrate, in g	Nb	Sn	Ta	Th	Ti	U	W	Y	Zr	La	Ce
26308	Stream sed	NA	NA	39	6	6	2	3700	4	3	24	260	48	77
26309	Soil	NA	NA	230	2	2	190	2400	51	3	29	3300	131	173
26925	Soil	NA	NA	200	2	2	300	1100	52	3	28	3500	235	250
26934	Pan con	9 kg	118.12	22	2	2	2	4600	2	3	23	190	36	68
26935	Stream sed	NA	NA	18	5	2	2	4000	2	3	25	160	27	51
26936	Pan con	13.5 kg	85.88	66	6	2	2	5500	3	3	25	420	56	92
26937	Stream sed	NA	NA	29	2	2	2	2800	2	3	23	150	37	62
25942	Stream sed	NA	NA	27	3	2	2	2700	2	6	22	160	35	56

Sample Number	Description
26308	stream sediment, see pan con 26309 and 26310
26309	soil sample to .3m depth
26925	soil sample to .2m depth
26934	gravel consists of syenite, hornblend syenite,hornblend diorite,and a coarse grained conglomerate
26935	stream sediment, see pan con 26934
26936	gravel is 80% syenite, bedrock is limestone-boulder conglomerate
26937	stream sediment, see pan con 26936
25942	stream sediment,

Table 4.- PAN CONCENTRATE, STREAM SEDIMENT AND SOIL SAMPLE ANALYSES, FROM THE KOOK CREEK DRAINAGE

analyses reported in ppm

Sample Number	Sample type	Total sample size	Concentrate, in g	Nb	Sn	Ta	Th	Ti	U	W	Y	Zr	La	Ce
25689	Pan con	18 kg	172.70	25	16	2	2	5600	2	3	27	190	76	132
25690	Stream sed	NA	NA	19	2	2	2	4900	2	3	21	160	38	69
25692	Pan con	18 kg	192.76	26	2	5	2	7000	2	3	28	150	53	93
25695	Pan con	18 kg	183.77	25	4	5	2	7700	2	3	28	180	56	98
26223	Stream sed	NA	NA	26	2	2	2	6900	2	3	26	160	36	70
26224	Pan con	9 kg	236.59	28	9	2	2	5700	2	3	28	320	112	191
26225	Stream sed	NA	NA	19	2	6	2	4000	2	3	20	150	39	75

Sample Number	Description
25689	syenite and metasedimentary gravel
25690	stream sediment, see pan con 25689
25692	100m below 50m waterfall, small fine fraction, minor black sand, gravel predominantly hornfels
25695	sample collected downstream of syenite/hornfels contact
26223	stream sediment, see pan con 26224
26224	syenite gravel, small fine fraction
26225	stream sediment, see pan con 26224

REFERENCES

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Appendix 1.- Detection limits and analysis method for rock samples.

ELEMENTS	DETECTION LIMIT	UNITS	METHOD	ELEMENTS	DETECTION LIMIT	UNITS	METHOD
SIO2	0.0100	%	XRF	NB	10.0000	PPM	XRF
AL2O3	0.0100	%	XRF	NI	1.0000	PPM	DCP
CAO	0.0100	%	XRF	PB	2.0000	PPM	DCP
MGO	0.0100	%	XRF	RB	10.0000	PPM	XRF
NA2O	0.0100	%	XRF	SB	0.2000	PPM	INAA
K2O	0.0100	%	XRF	SC	0.1000	PPM	INAA
FE2O3	0.0100	%	XRF	SE	3.0000	PPM	INAA
MNO	0.0100	%	XRF	SR	10.0000	PPM	XRF
TIO2	0.0100	%	XRF	TA	1.0000	PPM	INAA
P2O5	0.0100	%	XRF	TH	0.5000	PPM	INAA
LOI	0.0100	%	XRF	U	0.5000	PPM	INAA
AG	0.5000	PPM	DCP	V	2.0000	PPM	DCP
AS	2.0000	PPM	INAA	W	3.0000	PPM	INAA
AU	5.0000	PPB	INAA	Y	10.0000	PPM	XRF
B	10.0000	PPM	DCP	ZN	0.5000	PPM	DCP
BA	10.0000	PPM	XRF	ZR	10.0000	PPM	XRF
BE	1.0000	PPM	DCP	LA	0.5000	PPM	INAA
BR	1.0000	PPM	INAA	CE	3.0000	PPM	INAA
CD	1.0000	PPM	DCP	ND	5.0000	PPM	INAA
CO	1.0000	PPM	INAA	SM	0.1000	PPM	INAA
CR	10.0000	PPM	XRF	EU	0.2000	PPM	INAA
CS	0.5000	PPM	INAA	TB	0.5000	PPM	INAA
CU	0.5000	PPM	DCP	YB	0.2000	PPM	INAA
GE	10.0000	PPM	DCP	LU	0.0500	PPM	INAA
HF	1.0000	PPM	INAA	IR	20.0000	PPB	INAA
MN	2.0000	PPM	DCP	SUM	0.0100	%	XRF
MO	5.0000	PPM	INAA				

Appendix 2.- Detection limits and analysis method for pan concentrate, soil, and stream sediment samples.

ELEMENTS	DETECTION LIMIT	UNITS	METHOD	ELEMENTS	DETECTION LIMIT	UNITS	METHOD
NB	2.0000	PPM	XRF	W	3.0000	PPM	XRF
SN	2.0000	PPM	XRF	Y	2.0000	PPM	XRF
TA	2.0000	PPM	XRF	ZR	3.0000	PPM	XRF
TH	2.0000	PPM	XRF	LA	1.0000	PPM	INAA
TI	5.0000	PPM	XRF	CE	5.0000	PPM	INAA
U	2.0000	PPM	XRF				

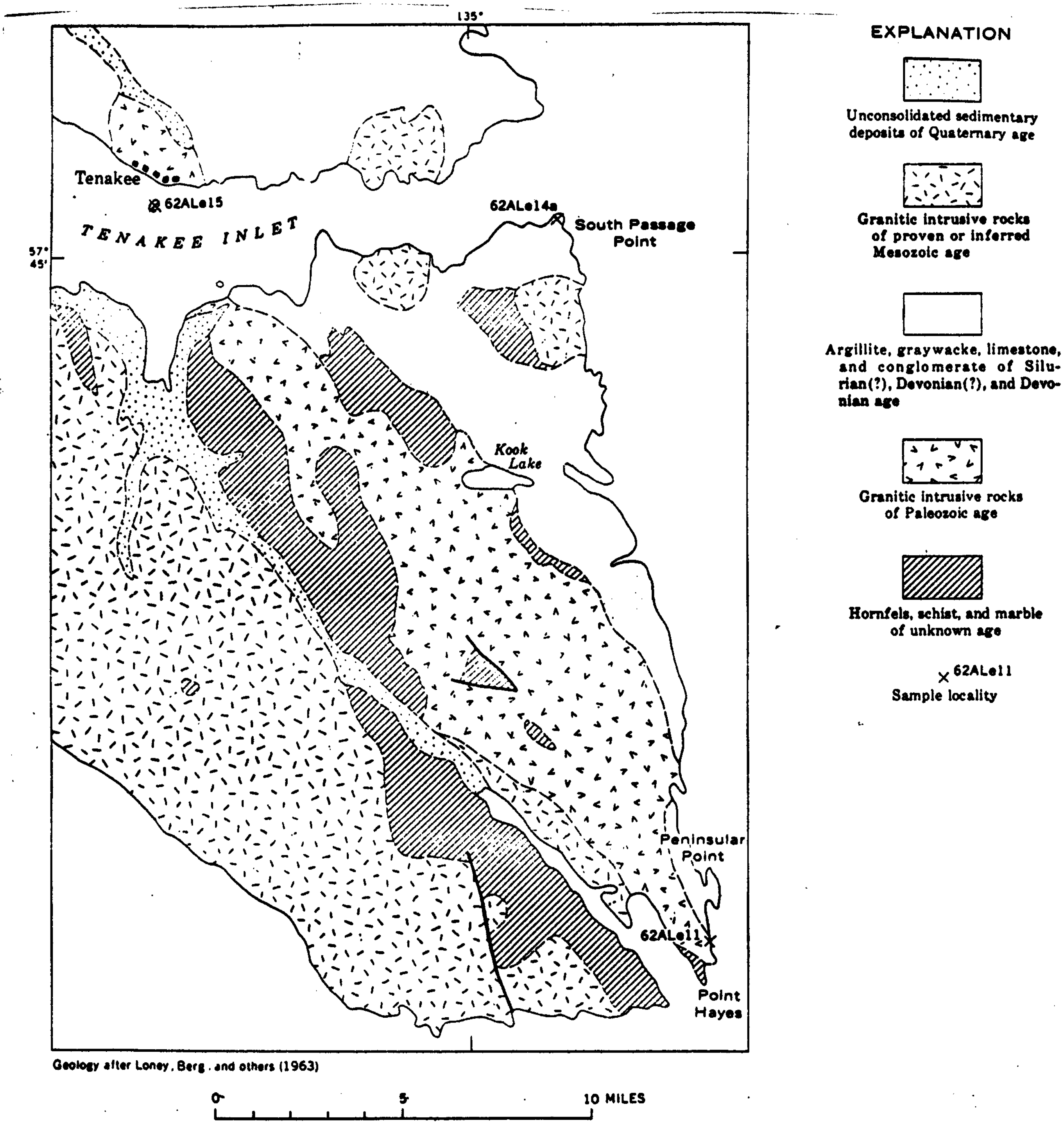

FIGURE 3.- Regional Geology map[2].

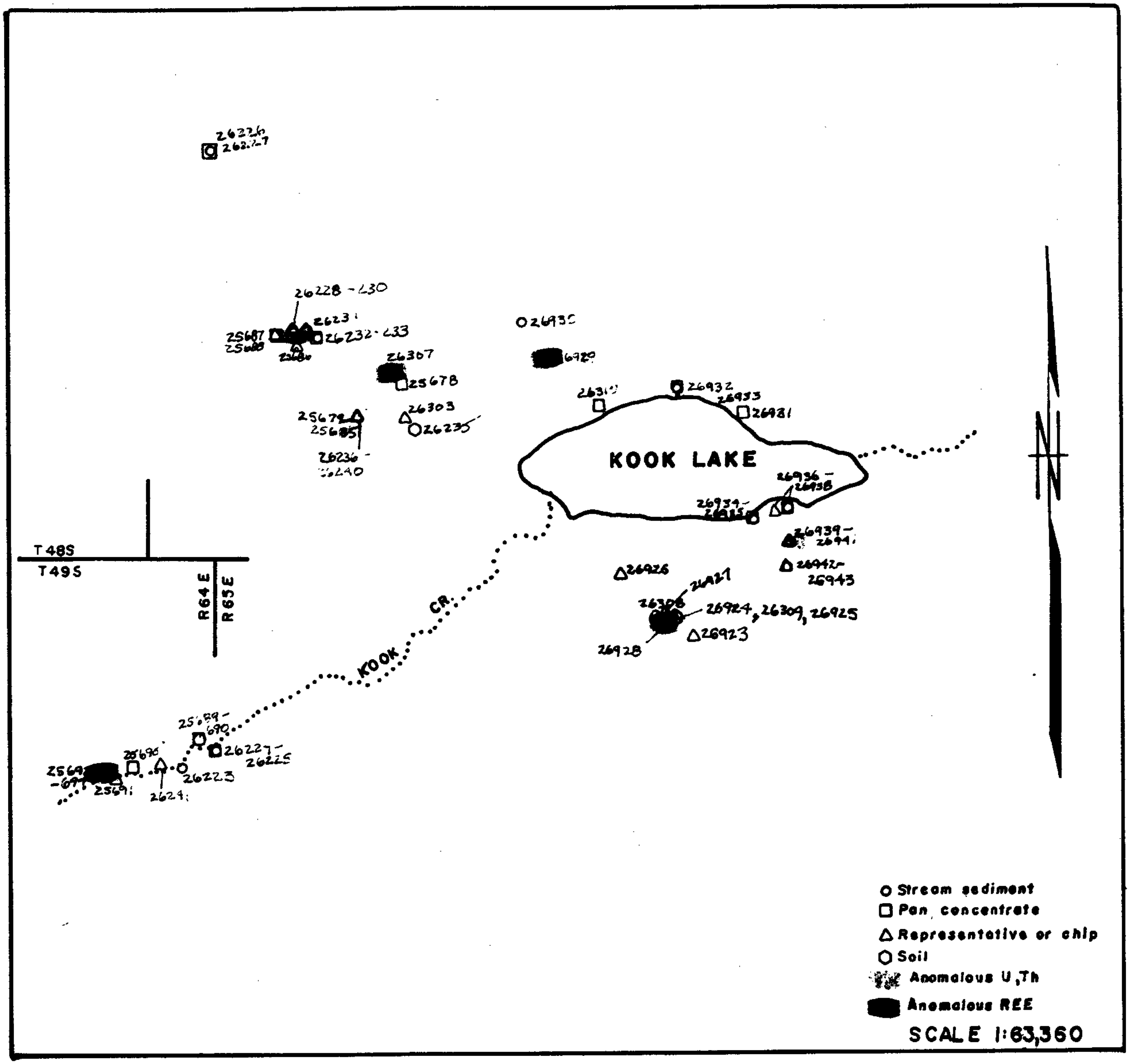

FIGURE 3.- Sample location map.